REMARKS/ARGUMENTS

The examiner is thanked for thoroughly reviewing the subject patent application. Applicants wish to point out the major features of their invention, which is a method for forming a hard bias layer within an abutted junction configuration for a spin-valve type GMR read head.

It is the central object of the present claimed invention to provide a method of forming a thin hard bias layer against the etched side of a spin-valve GMR sensor element to form an abutted junction configuration. Moreover, the magnetic properties of the bias layer at the junction should be enhanced, because it is found that as the width of sensors increasingly diminishes, it is the magnetic properties of the bias layer at the junction that dominate the performance of the sensor. Further, in order to be able to make the hard bias layer as thin as possible, it is also necessary to have very good lattice matching between the bias layer and the etched surface of the sensor against which it abuts. As is illustrated in Fig. 1 of the present application, the undersurface of the bias layer must form a contiguous junction with the etched surface of the GMR sensor element. This etched surface includes side edges of all the horizontal layers forming the GMR sensor element and, in addition, it includes a small extending portion of a first seed layer beneath the GMR sensor element, which is labeled (13). In order to accomplish the lattice matching against such a variety of materials and surface shapes, the present claimed invention teaches the formation of a second lattice matching seed layer (14) that covers all portions of the surfaces described above, on which seed layer the hard bias

layer is then formed. The seed layer meeting the objects of the invention is a layer of CrX formed over a layer of Ta, where X can be Ti, W, Mo, V or Mn. It is found by experiment that the Ta layer beneath a layer of CrTi most advantageously screens out the effects of the projecting tail of the GMR first seed layer (13). As noted in the application, such a projecting tail is an unavoidable product of the etching process used to form the surface for the abutted junction and it is the second seed layer of the present claimed invention that prevents that tail from adversely affecting the structure of the bias layer by creating a lattice mismatch. The hard bias layer, which is a layer of either CoCrPt, CoPt or CoCrTa, is, therefore, rendered structurally uniform by the presence of the seed layer. Applicants would make additional note of the fact that the significantly improved junction properties of the present claimed invention are substantiated by the empirical results presented in tables 1.1, 1.2, 2.1 and 2.2.

Having thus briefly explained the invention, Applicants would like to address the specific objections of the Patent Examiner in the numerical order in which they have been raised.

Substitution of a New Title

The currently amended claims of the present invention are directed towards a device and a method of its fabrication. The new title is believed to be more descriptive of the claimed invention.

Claim Rejections Under 35 USC 112

Applicants respectfully request the reconsideration of the rejection of claims 9-14, as currently amended, as being indefinite for failing to point out and distinctly claim the subject matter which applicant regards as the invention. Claim 8 is a proper device claim. Claims 9-14 improperly referred to claim 8 as a method claim. Amending claims 9-14 by replacing "method" with "sensor element" makes claims 9-14 properly dependent device claims.

Claim Rejections Under 35 USC 102

Applicants respectfully request the reconsideration of the rejection of claims 1 and 8, as currently amended, as being anticipated by Simion et al. (US Patent No. 6,185,081). In claims 1, 2, 3 and 4, Simion describes an abutted junction spin-valve GMR sensor in which a magnetic layer containing cobalt is lattice matched to a seed layer formed beneath it. The seed layer "adjoins" the junction edge and there may be an interlayer interposed between the seed layer and the hard bias layer. The magnetic layer "abuts" the junction edge. The seed layer of Simion contains NiAl (claim 3) or the seed layer contains MgO (claim 4). Either of these layers "adjoin," i.e. are contiguous with the side of the GMR sensor stack. The interlayer contains chromium (claim 2).

Simion's Fig's. 5,6, 7 and 8, all of which show embodiments of the device, show the magnetic layer (40), (75), (75) and (133) respectively in Fig's 5, 6, 7 and 8, directly abutting the junction edge with no seed layer between the magnetic layer and the edge. Although the magnetic layer is formed over the seed layer ((35) in Fig. 5), the seed layer is only below the magnetic layer and neither the seed layer nor the interlayer (37) are

between the magnetic layer and the junction edge. The figures are, therefore, all consistent with the wording of Simion's claim 1 in that the magnetic layer abuts the sensor edge, not the seed layer. Applicants will argue below that this is a significant and patentable distinction between Simion's invention and the present claimed invention.

The present claimed invention, as described in Fig. 1 of the application, shows a seed layer (14) interposed between the undersurface of the hard bias layer (16) and the etched surface of the GMR sensor at all points, so that the hard bias layer does not contact anything other than the seed layer. The illustration of Fig. 1 is consistent with the wording of currently amended claims 1 and 8, in which the seed layer is claimed as being formed over the surfaces for the abutted junctions and the bias layer is claimed as being formed over the seed layer, with the bias layer undersurface contacting only the seed layer. In the present claimed invention, the single seed layer for the bias layer covers all exposed surfaces over which the bias layer is formed. This configuration is consistent with the central object of the invention, which is to produce optimum magnetic behavior of the bias layer at the junction. By contrast, Simion's seed layer or his combined seed layer and interlayer, do not separate the bias layer from the junction edges. Therefore, Simion's junction formation does not produce the optimal magnetic properties of the bias layer at the junction that are produced by the present claimed invention.

Not only is the geometry of Simion's structure different from that of the present claimed invention, but the material composition of Simion's seed layer and the present seed layer are also different.

Simion's GMR sensor is formed on an MgO sensor seed layer, (57) in Fig. 6, which is exposed at the edges (column 5, line 37). The NiAl bias layer seed layer then

abuts against this exposed MgO GMR seed layer (column 5, line 43). Simion's interlayer (72) is then formed on this NiAl seed layer.

The present claimed invention uses a Ta first seed layer for the GMR element (claim 3) or a NiCr or NiFeCr seed layer (claim 2). The second seed layer for the bias layer is a layer of CrX (X being Ti, W, Mo , V or Mn) formed on an underlayer of Ta (claim 4). Thus, the Ta underlayer of the bias layer second seed layer contacts the exposed Ta of the GMR seed layer as well as all of the GMR sensor layer edges, producing the advantageous formation of the present claimed invention.

Applicants would, therefore, argue that the positioning of their bias layer only against a seed layer, with no part of the bias layer directly abutting the GMR junction, produces the enhanced magnetic properties of the bias layer in the region of the junction.

Claim Rejections Under 35 USC 103

Applicants respectfully request reconsideration of the rejection of currently amended claims 2-7 and currently amended claims 9-14, as being unpatentable over Simion et al. The present claimed invention forms a GMR sensor element on a Ta, NiCr or NiFeCr first seed layer, as claimed in claims 2, 3, 9 and 10. These seed layers are preferred materials for the performance of the sensor. The projection of a portion of these seed layers at the bottom of the abutted junction presented a significant problem with respect to the magnetic properties of the bias layer at the junction. The object of the inventors was to address the necessity of improving the properties of the bias layer, which they did with the second seed layer of the present claimed invention. In short, the second seed layer of the present claimed invention was experimentally found to

successfully meet the objects of the invention based on the use of the first seed layer to form the GMR sensor element. Simion, on the other hand, does not use the materials of these first seed layers for his GMR sensor element. While we agree with the Examiner that the prior art might suggest the use of the materials of the first seed layers of the present claimed invention, if Simion had used such seed layer materials, it is not obvious that his bias layer formation would have met the objects of his invention. Thus, applicants would argue that the prior art might well suggest other seed layer materials, as indeed they were used in the present claimed invention, but there is no suggestion that the second seed layer of the present invention or its placement against the abutted junction in accord with the present claimed invention, would then produce the results of the present claimed invention. Similarly, applicants would argue that the hard bias materials claimed in claims 6 and 13 are exactly the materials that will exhibit the improved magnetic performance at the junction when formed against the seed layer of the present claimed invention in the manner of the present claimed invention.

Conclusion

The Examiner is thanked for thoroughly reviewing the application. All claims discussed above are now believed to be allowable. If the Examiner has any questions regarding the above application, please call the undersigned attorney at 845-452-5863

Respectfully submitted,

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